Remarks of R. Stanley Williams

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Technology future for 21st Century California- Nanotechnology

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Senator Vasconcellos, distinguished panel members, and esteemed colleagues, I thank you for providing me - on behalf of Hewlett-Packard Company the opportunity to address you today.

Today we are seeing the beginnings of three great scientific revolutions that will lead to the technical and industrial foundations for the rest of this century:
molecular biology, information science, and nanoscience. Each of these three areas has the potential to completely revolutionize society - the combination of all three will produce more opportunities for the improvement of the human condition than have ever been seen in a single century. The molecular biology revolution is certainly the best appreciated of these, and the results of the information revolution are all around us. The nanotechnology revolution has perhaps the greatest potential for economic impact of the three; it is also the least understood and most shamelessly hyped.

Nanoscience, the study of structures that are a few atoms in size, is the scientific territory where hundreds of years of research advances in physics, chemistry and biology have converged in just the past few years. Now that all three disciplines have claimed the same turf, each has realized that it has much to learn from the others, which is causing traditional academic boundaries to blur and new fields to emerge.

The unifying scientific theme is that the intrinsic properties of matter, such as color, chemical reactivity, and electrical resistivity, depend on size and shape only at the nanoscale. Thus, nano-engineered systems will have the broadest possible range of properties that can be designed, which in turn means that building anything with control at the nanometer scale will enable them to be produced in the most efficient possible manner.

We must remember that nanotechnology is a collection of new tools available to a broad range of scientists and engineers - it is not a panacea nor complete solution to any problem. However, we will increasingly find that the crucial or enabling component of a system is engineered at the nanometer scale, and this will create huge opportunities for existing companies as well as create many new industries. Nano-engineering has the potential to greatly improve the properties of nearly every material object manufactured by humans, and will lead to the creation of new medicines, materials and devices that will substantially improve the health, wealth, and security of the worlds people. Indeed, Deutsche Bank in Berlin has estimated that the total value of nanotechnology-enabled products and services world-wide was already $116 billion last year, and some forecasts place the economic benefit of nanotechnology at over $1 trillion by the end of this decade.

The State of California can play the leading role in the advancement of nanoscale science and engineering, which in turn will drive innovation and new products that will improve peoples' lives. This is the key to our future prosperity - the internet bubble taught us, yet again, that a new economy is not built on clever business models, advertising slogans nor eyeballs, but on tangible goods that outperform their predecessors or perform new tasks that had no antecedents. The countries, regions, and companies that embrace and instantiate nanotechnology will prosper,

and those that do not will have to watch in envy. California has the know-how, the intellectual climate, the people and the institutions required to become the nanotechnology hub of the earth; and frankly, that is the best long-term solution to overcome the major financial challenges currently faced by the State. No other region on earth has the number and quality of institutions and scientists working in nanotechnology. An abbreviated list includes: all the UC campuses and many of our excellent private universities; the major DoE, NASA and DoD laboratories, the major corporate laboratories, and a large number of medium and start-up companies. However, having so many centers of excellence has turned out to be a problem. Since each center is already so strong and so occupied with its own problems, they have not been able to gather together to coordinate their activities as those in several other regions have. Thus, we have many strong but isolated efforts, whereas other regions have been able to create larger integrated and specialized programs. Thus, California actually lags significantly behind the efforts in several other states, such as New York, to dominate particular areas of nanotechnology.

Perhaps more importantly, the competition to dominate this new technology from overseas is stronger than the United States has seen since the end of the second world war. In the early 1960's, the US was investing most of the world's research dollars for developing microelectronics. That investment paid off handsomely for the country, and especially for California. However, in the area of nanotechnology, the US investment is no more that one fourth of the world's total, and thus we are already in a fierce struggle with Japan, Europe, Korea and China to be the first to bring these technologies to market. Given that in the early stages of a new technology, human cleverness is at a premium, it is only during that time

that most of the jobs are the high skill, high salary positions of the type sought by Americans. This is a struggle that we cannot afford to lose.

My primary concern for US nanotechnology is that we will not educate and retain enough of the best researchers to be the global leader. The European Union boasts that they invest twice as much as the US National Nanotechnology Initiative. Japan carefully examines the American Nanotechnology investment, and invests at least 10% more in any given calendar year. Other countries are determined to keep pace by investing heavily and, most importantly, by recruiting the best and brightest researchers away from the US. Clearly, this time we cannot lead the world simply by brute force outspending the competition.

Given the current economic climate, our desperately tight resources and the strength of the competition, how can California lead the world? The answer, of course, is to be bolder and smarter than anyone else. We will have to forge new methods of collaborating among our great research institutions. The diversity of California is a major advantage, since the scientists who have been drawn into the field of nanotechnology come from around the world. California must become the most desirable place in the world where researchers from academe, government and industry can work and discover together. Each of these groups posses tremendous strengths that complement the other, and it will only be by leveraging their capabilities that California can beat the global competition. This will require new partnerships - as well as mutual trust and humility. There must be a commitment to responsiveness that large bureaucracies can seldom muster.

To achieve these ends, a modest investment can yield very high returns. A small organization devoted to exploring public policy issues with respect to nanotechnology and looking for ways to coordinate efforts among the various sectors could help forge the links that would bring together the critical mass in California to really dominate an area. Such a group could be invaluable in establishing standards and agreements for interoperability, which are crucial for today's technologies. There was such a group at the beginning of the internet, the ISI or Information Sciences Institute, which was instrumental in creating the Web as we know it today. A similar Nano Sciences Institute could be a major advantage to the total California and US efforts in this key area. It is up to us to seize the initiative - if we don't do it soon, someone else will.

As my colleague at HP Labs Alan Kay has famously said, "The best way to predict the future is to invent it". We at HP look forward to working with you as we do just that.